CHAPTER 1

PROJECT OVERVIEW

1.1 Introduction

Future telecommunication network will be largely based optical fiber as the transmission medium. With the proliferation of fiber in May parts of telecommunication network, it becomes increasingly apparent that photonic switching and optical signal processing, including optical multiplexing, will play important role in the network evolution into all photonic networks.

The external sources such as voltage, current or thermal have been used to change the optical propagation characteristics, the basis of optical switching. For example a rearrange able no blocking polymer wavelength thermo-optic 4x4 switching matrix with low power consumption at 1550 nm has been worked out by using thermal to control the 4x4 switches. Recently, low power compact 2x2 thermo optic silica-on-silicon waveguide switch with fast response has been successfully shown by using MZI.

Thermal effect was used to activate the MZI. High performance wavelength multiplexing and demultiplexing optical channels spaced 100GHz apart (0.8nm spacing at 1550nm) has been shown by the device based on Mach-Zehnder interferometer.

Active wavelength switching technology is one of the latest approach in fiber optical communication in order to make wavelength division multiplexing (WDM)

becoming a better choice for switching technology, knowing that WDM can exploit the huge bandwidths of optical fiber. In this project we report the results of a simulation study on the dependence of wavelength using beam propagation method (BPM) on $LiNbO_3$ directional coupler (DC) switch. The variation of the output splitting ratio is the major outcome from the simulation.

This directional coupler switch, which we call as WDM switch, is also having the same behavior as a passive directional coupler but with variable coupling efficiencies when under an external field. By applying an external voltage of less than 10V, the change of coupling efficiency of each optical wavelength between. 1.10μm and 1.55μm can be observed.

1.2 Objective

- Define the material of Mach-Zehnder switch.
- Simulation using BPM-CAD.
- Optimization of Mach-Zehnder switch.

1.3 Scope of Project

- To understand the concepts and operational principles of different types of optical devices used as optical switching.
- Investigation some of the parameters (β, Refractive index, Width, Length, size, material) that are used for designing an optimum optical switch.
- Designing an optical switch by using MZI technique by using BPM CAD software.
- Analysis on Mach-Zehnder in terms of light coupling efficiency.

1.4 Problem Statement

- Using optical-electrical conversion switches results in expensive and non-reliable systems due to large coupling loss.
- By designing optical-optical switches, the performance of the system is proved much better.

1.5 Methodology

1.5.1 Case Study

This part covered a study case about different types of coupler for example, Fused fiber coupler, waveguide coupler, Mach-Zehnder interferometer.

1.5.2 Literature Review

This covered titanium diffusion in lithium niobate process upon the literature review through materials for design this choice was based on that it has low loss and switching voltage need to be applied is small which is normally below 10v, Further more, silicon based substrate normally acts passively to electric field. In designed electro-optic switch, material is the best choice due to its electro-optic and piezo-electric characteristics.

1.5.3 Optical Switch Design

Initially, the switch be design using Mach-Zehnder interferometer as a beginning, 2x2 switches be designed.

1.5.4 Simulation

The simulation will be done by using BPM_CAD. This simulation will show the propagation in the switch.

1.6 Thesis Structure.

This thesis consists of main chapters. The first chapter consists of a general introduction, the scope and objective of the project and also the flow of this thesis.

Chapter 2 is an introduction about Waveguide and Fiber-to-the-home. The chapter discusses in detail about the waveguide analysis and WDM system performance.

Chapter 3 studies about the optical switches and waveguide coupler and fiber coupler and Mach-Zehnder.

Chapter 4 in this chapter has simulation results and discuses the results.

Chapter 5 is a conclusion for this project. The chapter also has future works